INTRODUCTORY LECTURE

TO THE

COURSE OF CHEMISTRY,

DELIVERED IN

JEFFERSON MEDICAL COLLEGE,

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BY

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CORRESPONDENCE.

Jefferson Medical College, November 5th, 1848.

Professor Bache,

Dear Sir,—The members of your Class, being desirous of procuring your Introductory, delivered on the 18th of October, have appointed the undersigned a Committee of that body to respectfully solicit a copy of the same for publication.

Very truly yours,

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T. S. Crowly, Cork, Ireland.

Committee.

Philadelphia, Nov. 17th, 1848.

Gentlemen,—It is some days since I received your kind note, containing a request to be furnished with a copy of my Introductory for the present year, for publication. Thanking you for this mark of attention, I willingly comply with your wishes, and place the manuscript at your disposal.

Be pleased to accept my kind regards, and believe me to be

Your sincere friend,

FRANKLIN BACHE.

To Messrs. J. W. Drewry, President,
L. Brandt, Secretary,
I. L. Adkins,
A. Hardcastle,
P. S. Croom, &c., &c.
Committee.

INTRODUCTORY.

Allow me, Gentlemen, to congratulate you on the return of the season for commencing our active duties. Many of you are known to me as my pupils of former years, and not a few are here for the first time, intending to avail yourselves of the medical instruction, imparted in this College. To you all, Gentlemen, I tender the right hand of fellowship, and extend a most cordial welcome to our city of brotherly love.

As an Introductory to my Course for the present session, I propose to give you a sketch of the rise and progress of chemistry, interspersed with notices of some of the distinguished men who have adorned its annals.

Like the beginnings of the other sciences, the first dawnings of chemistry are obscured by the mists which envelope everything that relates to remote antiquity. From the seventh to the sixteenth century, the science was enriched by a number of important chemical facts; but they were chiefly derived from the labours of the alchemists, who, in consequence of their absurd pretensions, seldom drew the proper conclusions from them.

The principal alchemical writers were Geber, Roger Bacon, Albert of Cologne, Raymond Lully, and Arnold of Villanova. Geber probably lived in the seventh century. He is the first to describe alembics, crucibles, and chemical furnaces, and may be considered as the inventor of those instruments. Roger Bacon flourished in the thirteenth century, and was the most extraordinary man of his time. According to Mr. Brande, he anticipated Lord Bacon in his preference of inductive to abstract reasoning, and in his great reliance on experiment as the best means of enlarging the boundaries of science. He is generally considered as the inventor of gunpowder; for he describes a compound of saltpetre, sulphur, and charcoal, to which he attributes the property of exploding with a tremendous sound, and the power of producing effects by which cities and armies might be destroyed.

Albert of Cologne, a contemporary of Roger Bacon, was a voluminous writer, deeply skilled in the alchemical philosophy of the day. He does not appear, however, to have enriched chemistry by any notable discovery. The same may be said of Raymond Lully and Arnold of Villanova, who both wrote in the latter half of the thirteenth century, and died early in the fourteenth at an advanced age.

The next name of celebrity in order of time is that of Basil Valentine. He was born at Erfurth, in Germany, in the last year of the fourteenth century, and wrote about the middle of the fifteenth. Although an alchemist, his works abound in interesting observations and experiments; and so numerous are his discoveries, that he is justly entitled to be called the founder of modern chemistry. His chief works are his "Currus Triumphalis Antimonii," and his "Haliographia," or treatise on the salts then known. Besides enriching the Materia Medica with a number of valuable antimonial preparations, he is the first writer who accurately describes the processes for preparing nitric, muriatic, and sulphuric acid. He is also the first chemist who mentions the power of nitric acid, when mixed with sal ammoniac, to dissolve gold. He appears to have been acquainted with both of the original processes for obtaining sulphuric acid; namely, the distillation of green vitriol, and the burning of a mixture of sulphur and nitre under a glass bell. The latter process continued to be employed until 1746, when Dr. Roebuck, of Birmingham, made the capital improvement of substituting chambers lined with lead, for the glass vessels previously used.

Next to Basil Valentine, it is proper to mention Paracelsus. He was born near the end of the fifteenth century, and died at Saltzburg, in Germany, from the effects of intemperance, at the age of forty-two, at the very time when he boasted the possession of the elixir of immortality! From his writings it may be inferred that he was a vain-glorious enthusiast, who had formed an exalted estimate of his own powers. It does not appear that he made any chemical discovery; and the only merit that can be claimed for him, was his bringing into use the mineral remedies, as contra-distinguished from the galenical or vegetable medicines.

The next name of note that we find in tracing the history of chemistry, is that of Van Helmont. He was born towards the close of the sixteenth century, and flourished in the early part of the seventeenth. A disciple and admirer of Paracelsus, he was incomparably his superior, both in the acuteness of his observations, and the solidity of his views. In his writings the term gas first occurs, and he was the first to make the distinction between condensible and incondensible aeriform fluids.

Contemporary with Van Helmont, lived that extraordinary genius, Lord Bacon. His great merit consisted in the reform which his admirable writings effected in the mode of philosophizing, by pointing out the utter futility of the systems of the ancients, and by indicating the path of induction from rigid experiment, as the only sure road to truth. While we pause to pay a tribute of gratitude to this great man for his services to science, how painful it is to be forced to admit that his bright fame as a philosopher, was tarnished by his conduct as a man.

In consequence of the light shed by the writings of Lord Bacon on the true mode of proceeding in extending the boundaries of science, the seventeenth century commenced under propitious circumstances, and, by the middle of it, a host of scientific inquirers appeared in the field, and not a few in the domain of chemistry. Among the latter were Brandt of Hamburg, Kunckel, Lemery the elder, and Glauber of Amsterdam. Brandt discovered phosphorus in 1669, and, in consequence of its surprising properties, general attention was drawn at the time to the study of chemistry. Kunckel wrote on phosphorus and glass-making, and cultivated chemistry chiefly as applied to the arts. Lemery flourished about the year 1673, and was distinguished as an experimentalist and public lecturer. But to Glauber is the meed of praise particularly due, not so much for the brilliancy of his discoveries, as for their number and importance. It is to him we owe the production of the volatile alkali from bones; the preparation of sulphate of ammonia, and its conversion into sal ammoniac by distillation with common salt; the production of blue vitriol; the extraction of vinegar from wood; the distillation of muriatic acid from a mixture of common salt and sulphuric acid; and the extraction

of the residual salt of this process, called after him Glauber's salt. Besides making these important contributions to the stock of chemical facts, he has the merit of being the inventor or improver of several pieces of chemical apparatus, which continue to be in use to the present day.

In tracing the progress of chemistry in the seventeenth century, the important influence of the Royal Society of London, and of the Royal Academy of Paris, both established within that period, must not be overlooked. The former was instituted in 1662, under the auspices of Charles II.; the latter in 1666, under the protection of Louis XIV. Among the early members of these societies, we find the distinguished names of Boyle and Hooke in England, and of Homberg, Geoffroy, and the two Lemerys in France. Homberg discovered boracic acid and pyrophorus; and Geoffroy deserves to be mentioned as a successful cultivator of pharmaceutical chemistry, and as the compiler of the first Paris pharmacopœia. To Boyle and Hooke belongs the rare merit of having adopted the inductive philosophy of Bacon, and of having pursued science in the genuine path of observation and experiment.

It was in the seventeenth century, that the phenomena of combustion began to attract particular attention. Before that period, some obscure surmises had been thrown out by the alchemists in relation to its nature; and it seems to have been considered by them as dependent on violent vibrations among the particles of the combustible, whereby they were converted, in part, into heat and light. About the year 1630, a remarkable essay appeared, by a French physician, named John Rey, in relation to the increase of weight which tin and lead acquire during calcination. According to the crude theory of the day, this process should have rendered the metals lighter, by the loss of the particles, alleged to be transformed into heat and light; but, instead of a loss, there was an augmentation of weight, which Rey correctly ascribed to the fixation of air.

Boyle and Hooke, apparently without any knowledge of the publication of Rey, afterwards instituted experiments on flame and combustion, which went far to support and extend the explanation of Rey, as to the cause of the increase of weight experienced by metals during calcination. Rey had proved the

fixation of air during the calcination of metals; and Boyle and Hooke showed that the presence of air was necessary in all cases of ordinary combustion, by finding that combustibles would not burn in an exhausted receiver. Hooke, indeed, carried his observations still farther, and came very near the truth. He speaks of air as the dissolvent of inflammable bodies, and attributes the heat generated to their solution. He afterwards qualifies his statement by saying, that it is only a part of the atmosphere which performs the solvent office; being that part, namely, which is similar to, or the very same as, the air fixed in saltpetre. Here the sagacity of Hooke recognises the modern oxygen, and identifies it as existing both in the atmosphere and in saltpetre.

The next name of celebrity that we meet with in pursuing our sketch, is that of John Mayow. He was born in Cornwall in 1645, and died in London at the early age of thirty-four. To him belongs the merit of having extended the views of Hooke, in relation to combustion. He gave to the air, noticed by Hooke in saltpetre, and recognised by him as forming part of the atmosphere, the name of nitro-aerial particles, and explained the increase of weight, attributed by Rey to the condensation of the air, to the fixation of these particles. He also traced, with wonderful sagacity, the analogy between the phenomena of combustion and of respiration; and, upon making comparative experiments as to the effects of the respiration of an animal, and the combustion of a candle, in a confined portion of air, he arrived at the conclusion, that his nitro-aerial particles were absorbed in both cases. Upon examining the residual air, after standing over water, he found that it was a little lighter than atmospheric air, that it extinguished flame, and that it was not absorbed by water; thus clearly describing the chief properties of the modern nitrogen.

Notwithstanding the clearness of the views of Hooke and Mayow on the subject of flame and combustion, it is remarkable that their opinions were almost wholly overlooked, and a theory of combustion came into vogue, commonly called the phlogistic theory, which had been promulgated in Germany by Beccher and Stahl, towards the close of the seventeenth cen-

tury. According to this theory, there exists in combustibles a principle of inflammability of extreme tenuity, subject to a peculiar vibratory motion, in which state it constitutes fire. To this principle Stahl gave the name of phlogiston. When phosphorus burns, as it is well known, it is changed into an acid matter, and produces fire. Hence, said Stahl, phosphorus consists of this acid matter, united with phlogiston, which, upon being extricated, appears as fire. Again, it was alleged that the acid matter, by being heated with charcoal, regains its phlogiston from that substance, and returns to the state of phosphorus. Thus, the acid matter was absurdly held by Stahl to be a simple body, and the phosphorus to be a compound of the acid matter with phlogiston.

Stahl set forth his doctrine of phlogiston with wonderful plausibility, and supported it by numerous experiments, which gave it the semblance of well-established truth. A few years before his death, which took place in Berlin in 1734, he published a full exposition of his chemical doctrines in his two works, severally entitled "Three Hundred Experiments" and "Fundamenta Chemiæ."

It is a fatal objection to Stahl's theory of combustion, that his principle of phlogiston was purely hypothetical; but even admitting that there were plausible grounds for believing in the existence of fire as a distinct material principle, still the theory failed to explain the increase of weight which the combustible sometimes acquires during combustion, or to give a correct solution of the indispensable agency of the air.

Some of the Stahlians attempted to get over the objection of the increase of weight of the combustible, by the absurd allegation that phlogiston was a principle of *levity;* and, therefore, rendered bodies lighter when combined with them, and heavier when separated!

Notwithstanding these insuperable objections to the phlogistic theory, it maintained its ground for more than fifty years, and was not overthrown until towards the close of the last century, when it fell before the masterly experiments of Lavoisier. This chemist utterly denied the existence of phlogiston, and, of course, its agency in combustion. He considered this process to be carried on by the oxygen of the air, the ponder-

able part of which unites with the combustible; while its light and heat, on which its aeriform state depends, are rapidly extricated, with the appearance of fire. This he proved by burning substances in oxygen, and afterwards collecting and weighing the products. The increase of weight always corresponded with the quantity of oxygen consumed. In making these experiments, Lavoisier, it is true, only confirmed and extended what had been previously observed, though in a less methodical manner, by Boyle, Hooke, and Mayow; but still this circumstance does not detract from his great merit, when we consider with what care he compared facts, and with what cogency of argument he maintained his views.

All those airs which are capable of sustaining flame, Lavoisier called *supporters of combustion.* According to him, the only elementary air which is a supporter, is oxygen; and compound airs, when they possess that property, owe it to the presence of this element. This restriction of the power of sustaining combustion to a single element, has been shown, by the progress of discovery, to be not well founded; for several elements, such as chlorine, iodine, bromine, and sulphur, have been proved, under certain circumstances, to be supporters of combustion. The discovery, however, of a plurality of supporters does not militate against the principle of the Lavoisierian doctrine, but rather gives it extension.

Having thus given an outline of the theories of combustion, brought down to the present time, we return to the seventeenth century, to notice the further labours of Mayow.

We have already spoken of the merits of Mayow, in having followed in the footsteps of Hooke, extending his observations on air and flame, and adding many of his own. But he appears as an original inquirer in another department, in which the credit is exclusively his own. In his essay on the "Mutual Action of Salts of contrary Kinds," he rejects the then received doctrine, that substances combine in consequence of the forms of their particles being such as to allow them to fit together. On the contrary, he attributes chemical combination to an attraction, and, in support of his views, clearly states a number of cases of what is now called single and double elective

affinity. In these views he anticipated Newton, who, in his sketch of a theory of chemical attraction, gives the same explanations that Mayow had previously done, and sometimes nearly in the same words. Following up the observations of Mayow, we find Geoffroy, in 1718, adopting a tabular form for representing the order in which bodies separate each other from combination. This plan of representing chemical affinity was extended and improved between 1751 and 1758, by Gellert and Limbourg, and finally led, in 1775, to the construction of ample tables by the great Swedish chemist, Bergmann. According to Bergmann, chemical attraction, as exerted between different bodies, is of different strengths, and may be represented by numbers. When one body is presented to two others in combination, the added body often combines with one constituent of the compound body, to the exclusion of the other. Here it seems as if the added body made a *choice* between the two bodies in combination; and hence the origin of Bergmann's expression, *elective* attraction.

Bergmann's tables had great value, on account of the precision with which they were drawn up, and the fullness of their details; but he was in error in supposing that the order of the substances in his tables, represented the relative force of affinity. The tables, indeed, denoted the order of decomposition; but this was not always the order represented by affinity; for the pressure of the atmosphere, elasticity, heat, and other causes modify the latter in particular cases.

The equivalent property of the combining weights of chemical bodies has led to the promulgation of a theory, called the atomic theory, according to which, bodies are supposed to unite by their ultimate particles, or atoms, the relative weights of which correspond with the relative weights of the combining bodies themselves. The first arguments and suggestions, in favour of the probability of an atomic mode of combination between chemical bodies, were presented by Dr. William Higgins, of Dublin, in the year 1789, in a pamphlet, entitled a "Comparative View of the Phlogistic and Antiphlogistic Theories;" but his views attracted little attention at the time, and the author himself does not appear to have been aware of the important general laws to which they led. Be-

tween 1792 and 1802, Richter, of Berlin, published a series of tables, in which he proved that the same proportions of the different bases which saturate a given weight of one acid, will saturate the same weight of all other acids, and vice versâ. This amounted to the same thing as proving the equivalent property of the combining weights; and yet it does not appear that Richter was led to conjecture an atomic mode of combination, to explain the curious relation of the numbers obtained in his experiments.

In 1808, Dalton published the first part of his "New System of Chemical Philosophy," in which he announced the atomic theory, as founded on the equivalent property of the combining numbers; as also on the law of multiple proportions, which he was the first to observe. In consequence of this publication, the theory attracted general notice; and, as a direct induction from facts, it is now universally received as a doctrine of great probability.

Soon after the appearance of the work of Dalton, Gay-Lussac published a paper on the combination of gases, in which he proved that aeriform fluids unite, in bulk, in equivalent and multiple proportions. These observations served to confirm the views of Dalton, so far as the gases are concerned; for, if Dalton was right in announcing the general law of equivalent and multiple combining weights, it followed necessarily that gases, in uniting, must exhibit equivalent and multiple combining volumes.

In this sketch of the laws of combination and the atomic theory, I must not omit to mention Berzelius. He began his labours in investigating these subjects in 1807, and far exceeded his predecessors in the importance of his facts, and the comprehensiveness of his views. By making an almost incredible number of analyses, he determined the equivalent numbers with a precision that had never before been attained; and, by comparing his results, he was enabled to make out the atomic composition of many substances with great probability. Finally, by devising symbols, he put it in the power of the chemist to express the constitution of complex compounds in a clear and concise manner.

Recent information has reached this country, of the death of

Berzelius, at the age of 69. In his loss, chemical science has been deprived of its most successful cultivator. The son of a clergyman, he was born on the 20th of August, 1779, in Ostergöthland; in Sweden. In the earlier part of his life, he had to struggle with poverty; but his ardent spirit enabled him to surmount all obstacles. At the age of seventeen, he entered the University of Upsal, where he made rapid progress in his studies, particularly in chemistry. In 1804, at the age of twenty-five, he graduated as doctor of medicine, and soon after received the appointment of adjunct professor of medicine and pharmacy in the medical college of Stockholm. He was appointed full professor in 1807, and, in the same year, founded the medical society of Stockholm, now the most flourishing medical institution in Sweden. In 1808, he was elected a member of the Swedish Academy of Sciences, and, in 1810, was raised to the office of its president. In 1818, he was appointed perpetual secretary of the Academy, and, in virtue of his office, he has ever since prepared his admirable annual reports of the progress of chemistry, each report forming a large octavo volume. In the course of his life, he visited various foreign countries, in pursuit of scientific knowledge; namely, England in 1813, France in 1819, Bohemia in 1822, and Germany in 1830 and 1835. His scientific labours embrace every department of chemistry. Notwithstanding his constant occupation in experimental research, he found time to compose a number of scientific treatises, more or less extensive. Besides twenty-eight volumes of annual reports of the progress of chemical science, he published a system of chemistry in ten volumes, lectures on animal chemistry in two volumes, and works on natural philosophy and mineralogy in six volumes. Most of these works have been translated into the English, French, German, Italian, Spanish, and Polish languages. Many now eminent chemists enjoyed the advantage of practical instruction in his laboratory. Of these may be mentioned, Bonsdorff, Engelhardt, Gmelin, Turner, Johnston, Magnus, E. Mitscherlich, Osann, Gustavus and Henry Rose, and Woehler. Long will science have cause to deplore the loss of this illustrious man.

Having traced the subject of chemical affinity from the period of the first rude observation of an attraction by Mayow, to the

present time, when the facts observed have been reduced to fixed laws, and explained by the atomic theory, we return again to the chemists of the seventeenth century.

We have seen that, in this century, Hooke, Mayow, and a few others had the merit of laying the foundation of chemistry as a science, on which their successors of the eighteenth century raised the superstructure. The first name of celebrity that we meet with here is that of Dr. Stephen Hales, an English clergyman, who was born in 1677, and died in 1761, at the advanced age of 84. He may be justly considered as the founder of pneumatic chemistry, though anticipated, in some respects, by Mayow. He made his first communication to the Royal Society about the year 1717, and published his "Statical Essays," and his "Attempt to analyze the Air," in 1727. From the details which he gives of his experiments, it is evident that he obtained oxygen from nitre; hydrogen from dilute sulphuric acid and iron; and carburetted hydrogen from bituminous coal. But, unfortunately, he had adopted the erroneous notion, that all kinds of air are mere modifications or contaminations of common air, and, consequently, did not draw correct conclusions from his own experiments.

The next name to be presented to your notice is that of Dr. Joseph Black. Sprung from a Scottish family, he was born in France in 1728, and died in 1799 at the age of 70. He was successively appointed Professor of Chemistry in Glasgow in 1756, and in Edinburgh in 1766, and contributed essentially to the reputation of the Edinburgh school by his important discoveries, and great merit as a lecturer. The causticity of the alkalies and earths was then attributed to various causes. By some it was referred to the fixation of igneous particles; by others, to an acrid acid contracted in the fire. Black found that, if a mild alkali be added to a solution of Epsom salt, the precipitated magnesia effervesced with acids; but, after having been heated red-hot, it weighed less, and would no longer effervesce. Limestone, he found also to lose weight in the fire, and, at the same time, to become caustic. Being thus led to infer that gaseous matter was driven off during these calcinations, he added an acid to common lump magnesia in a vial, so arranged as to collect any gas that might be evolved. The result was, that he obtained a

considerable quantity of a gaseous substance, now known as carbonic acid. In this way he proved that the causticity of the alkalies and earths depends upon the separation of carbonic acid, and not upon the fixation of any new matter.

Another department of inquiry in which Black distinguished himself, was the investigation of the agency of heat in producing the liquid and aeriform states. He discovered that, in the passage of solids into liquids, and of liquids into aeriform fluids, a portion of heat was absorbed, not sensible to the thermometer. To this portion he gave the name of *latent heat*. He found that the quantity of heat, thus absorbed, was particularly great upon the conversion of water into steam; and that an equal portion was given out on the occurrence of the contrary change. There is every reason to believe that his sagacious observations on this point greatly assisted the celebrated Watt in devising his capital improvement in the steam engine, of causing the steam to be condensed in a separate vessel.

We have already spoken of Hales as the founder of pneumatic chemistry. We now come to speak of the philosopher who raised the greater part of the superstructure. Priestley, to whom we allude, was born in England in 1733, and died at Northumberland in this state, in 1804, at the age of 71. To him belongs the merit of first employing the mercurial cistern, for the collection of gases absorbed by water. It is impossible to do more than give a catalogue of his labours, so numerous and important were his discoveries. On the 1st of August, 1774, he discovered oxygen gas, by him called dephlogisticated air. Scheele discovered the same gas a short time afterwards, without being aware of the previous discovery of Priestley; but the claim set up by Lavoisier as a third independent discoverer, has been shown by Priestley to be unfounded. Soon after the discovery of oxygen, Priestley added to the stock of known gases, muriatic acid gas, ammonia, and sulphurous acid; and made known the principal properties and eudiometrical applications of nitric oxide, though not the discoverer of this gas, it having been previously noticed by Mayow.

Two years previous to the discovery of oxygen, namely in 1772, the other constituent of the atmosphere, now called nitrogen, was discovered by Dr. Rutherford, of Edinburgh.

Before that time, this gas appears to have been confounded with carbonic acid; but, though, like that acid, it extinguishes flame, and is unfit to support respiration, Rutherford proved it to be a totally distinct gas.

We had occasion to mention Bergmann incidentally, when giving a sketch of the progress of our knowledge in relation to chemical affinity. We now recur to his name for the purpose of rapidly noticing his other labours. He was born in Sweden in 1735, and died in 1784, at the age of 49. He was the first chemist who gave anything like precision to analytic chemistry. In his essay on mineral waters, he presents a full account of tests, many of them discovered by himself, and points out the limits of their indications. He preferred the method by the humid way to that by igneous analysis; and, in his essay on the former method, laid the foundation of that branch of analytic chemistry, so successfully extended and improved by Klaproth, Vauquelin, Stromeyer, and others. Upon the whole, Bergmann may be characterized as a philosopher of the first order. He employed great method in his investigations, and seldom strayed from the path of inductive research.

Bergmann was followed by those extraordinary men, Cavendish and Scheele. Placed in opposite circumstances in life, they attained the highest eminence as chemical philosophers, but by pursuing different routes. Cavendish was born in England in 1731, and died in 1810, aged 79. Descended from a noble family, and possessed of a princely fortune, he became a leading personage in the scientific circles of London. He enriched chemical science by two capital discoveries, namely, the constitution of nitric acid, and the composition of water. Hydrogen, indeed, had been obtained by Mayow, and Hales had noticed its inflammability; but its other properties, and the product of its combustion had not been ascertained. It is true that Macquer, in 1766, had noticed a deposition of moisture on its explosion, and Watt, in 1783, had accounted for this moisture, by supposing the synthetic production of water; but it was not until the succeeding year, that full experimental proof was adduced, that the product of the combustion of hydrogen is water; and this proof was presented by Mr. Cavendish, in a paper read before the Royal Society in 1784. His conclusions

were subsequently verified analytically by Lavoisier, who succeeded in decomposing water by passing steam through a red-hot tube containing iron.

Scheele was born in Sweden in 1742, and died in 1786 at the age of 44. He was brought into notice by Bergmann, who had the sagacity to discern the first indications of his genius; and when his rising fame bade fair to eclipse his own, he felt no mean jealousy at his success, but continued, as long as he lived, to uphold his rival and friend.

Besides the discovery of oxygen, the honour of which he shares with Priestley, Scheele first obtained the bleaching gas, called by him dephlogisticated marine acid, afterwards termed oxymuriatic acid by Berthollet, and, finally, chlorine by Sir Humphry Davy. The merit of first suggesting the application of this gas to the purposes of bleaching, belongs to Berthollet.

Scheele enriched mineral chemistry by the publication of several important essays, among which may be mentioned his papers on fluor spar and its acid; on magnesia and its salts; on tungsten; on the arsenite of copper as a pigment; and on the preparation of calomel in the moist way. He was the first to describe the acids of arsenic and molybdenum, and to point out the difference between the native sulphuret of molybdenum and plumbago. He also made important contributions to organic chemistry in his essays on milk and sugar of milk; on lactic, saclactic, and benzoic acid; on the best method of obtaining citric, and some other vegetable acids; on ether; and on urinary calculi. Nearly his last contribution to science was a masterly paper on the colouring matter of Prussian blue, in which he details his discovery of prussic acid; but he was not so fortunate as to obtain it in a concentrated state, or to make out the precise manner in which its constituents are united.

In another part of this address, we had occasion to mention Lavoisier, as the founder and most successful expositor of the antiphlogistic theory of combustion. We now recur to his name, in connexion with the reform of chemical nomenclature, which he effected in conjunction with a number of French savans, among whom the most eminent were Morveau,

Fourcroy, and Chaptal. This reform greatly facilitated the acquisition of the science, by substituting for the unmeaning names previously in use, others expressive of the properties or composition of the different substances; and though the progress of chemistry has made some modifications of the French nomenclature necessary, still, in the main, it continues to be the language of the science.

Lavoisier published an elementary treatise on chemistry in 1789, in which he presents a connected view of his doctrines and discoveries. This work possesses the merit of being a methodical exposition of the then existing facts of the science, presented in a clear style. Had his life been spared, we may presume that he would have continued to enrich science for many years with important contributions; but alas! he was swept away by the whirlwind of the French revolution. He perished by the guillotine in May, 1794, in the 51st year of his age.

Among the causes which have promoted the rapid progress of chemical science in our own day, none have been more influential than the discovery of the relation between electrical and chemical forces. The first step in this branch of scientific inquiry was made, in 1790, by an Italian philosopher named Galvani, and consisted in observing that contractions were excited in the muscles of a frog, by the contact of dissimilar metals. This led Volta, another Italian, to attempt to multiply the effect; and this he succeeded in doing, by subjecting alternations of dissimilar metals to the action of chemical agents. In this way the galvanic pile and trough were successively invented, and the foundations laid of that branch of electrical science, called galvanism.

Among the earliest observed and most striking of the powers exerted by galvanism, was that of effecting chemical decomposition. By availing himself of this power, Sir Humphry Davy was led into a path of research which laid the foundation of his brilliant fame. Having found that the strength of this power was in proportion to the size of the battery employed, he was led to conclude that substances, previously deemed elementary, might prove to be compound, if subjected to galvanic combinations of sufficient energy. The experi-

mental trials confirmed his anticipations; for, in 1807, he succeeded, by means of the great galvanic battery of the Royal Institution, in resolving the fixed alkalies, then known, into peculiar radicals and oxygen. The radicals obtained, called potassium and sodium, proved to be metallic, and to be possessed of many curious and unexpected properties. Pursuing his researches, he showed that the alkaline earths also were oxides of peculiar metals.

The next researches of importance, undertaken by Sir Humphry, were those on the bleaching gas, which he proved, in his Bakerian lecture of 1810, to be an undecompounded body, and for which he proposed the name of chlorine, now universally adopted. At the same time he demonstrated that muriatic acid is a compound of chlorine and hydrogen. The gradual admission and final adoption of his novel views respecting chlorine and muriatic acid, though vehemently opposed at first, was a great triumph for his genius, and added materially to his fame.

Davy published his "Elements of Chemical Philosophy," in 1810, and shortly afterwards, a work on agricultural chemistry. Between 1815 and 1817, he communicated to the Royal Society his researches on flame, which led to his invention of the safety lamp.

Sir Humphry Davy may be viewed as the most distinguished of the English chemists. He continued to enrich science by his profound views and able experimental researches, until within a short time of his death, which took place in May 1829, in the 52d year of his age.

In this sketch it would be unpardonable to omit to notice the labours of Dr. Wollaston; but our time will only permit us to give a list of his principal memoirs and discoveries. In 1797 he published a paper on gouty and urinary concretions, adding considerably to our knowledge of these substances. In 1808 his paper on super-acid and sub-acid salts was the means of awakening the attention of chemists to the subject of multiple proportions, and proved very influential in establishing the doctrine of equivalent numbers and the atomic theory. Besides being the inventor of the scale of chemical equivalents, he was the discoverer of palladium and rhodium, and the perfecter of the process for rendering platinum malleable. His death took

place in December 1828, about five months before that of Sir Humphry Davy.

The loss of two such men within so short a period, and of Vauquelin, which took place about the same time, was a heavy calamity for the cause of science. But while we regret the illustrious dead, let us be cheered by the recollection of the fact, that many distinguished men yet remain, active labourers in the field of chemical science. To prove this, it is only necessary to mention the names of Brande, Phillips, Faraday, Graham, and Fownes in England; of Thomson, Christison, and Gregory in Scotland; of Kane in Ireland; of Gay-Lussac, Thenard, and Dumas in France, and of Mitscherlich, Woehler, and Liebig in Germany.

Since the death of Berzelius, Liebig may be considered as the most distinguished of living chemists. Born at Darmstadt, in Germany, in 1803, he is now only forty-five years old. At the age of fifteen, he was placed with an apothecary for two years, for the purpose of acquiring a practical knowledge of the operations of pharmacy. After completing this course, he pursued his chemical studies for several years under the best masters of Germany. When about twenty years of age, he was enabled to visit Paris, where he was so fortunate as to gain the friendship of the celebrated Humboldt, by whom he was recommended to the favourable notice of Gay-Lussac. That eminent chemist opened his laboratory to him, in which he completed his researches on the fulminic acid. After his return from Paris, he received the appointment of professor of chemistry in the University of Giessen, an appointment which he holds to the present day.

It is not my purpose to attempt a biographical sketch of Liebig. Suffice it to say, that, like Berzelius, his researches embrace the whole circle of chemical science. But it is in organic chemistry particularly that he has distinguished himself; and, indeed, this department of the science may be said to have been almost re-created by him. His chemical contributions to animal and vegetable physiology are numerous and important. His works on animal and vegetable chemistry contain many new facts; but his physiological speculations, though novel and ingenious, rest, in many instances, on an insufficient basis of observation and experiment.

I have thus, Gentlemen, presented to you an outline of the history of chemistry, and brought under review the labours of those illustrious men who have distinguished themselves as its cultivators. In the progress of my Course, I shall have occasion to mention other names of more or less note, which, in the present address, I have been compelled to omit, in order to keep within the limits assigned to an introductory discourse.

The few minutes that yet remain to me, before concluding this address, I shall devote to indicating the character which I propose to give my Course. I shall keep the fact steadily in view, that I am the lecturer on chemistry in a medical school, and that, consequently, it must be my duty to teach the science in its application to medicine. In presenting the facts of the science, I shall pursue a strict classification, the chemical medicines being described, each in its proper place, as determined by the arrangement adopted. Substances will be briefly touched upon which are remotely connected with the Materia Medica, and the time thus gained will be devoted to a comparatively extended notice of pharmaceutical preparations. Organic chemistry will be treated of as fully as the limits of the Course will permit.

Need I add, Gentlemen, that, whatever pains I may take to instruct you, still much will depend upon yourselves. Study, diligent study, and a faithful attendance on the lectures, are essential to your success. That there is no royal road to knowledge, is equally true of chemistry as of geometry. Its principles can only be mastered by persevering study. Your success depends, not so much upon your intellectual endowments, as upon your industry. After an experience of more than twenty-six years as a lecturer, I can truly say, that I have almost invariably found those students most proficient, independently of their natural endowments, who were most diligent in pursuing their studies. Determine, then, my young friends, to begin aright. Be not satisfied with obscure mediocrity. Aim at the highest proficiency, and though you may fall short of your aim, yet you will accomplish more than if you had set to yourselves a lower standard. This course is not merely due to yourselves; it is demanded by your duty to your friends, to your profession, and your country.